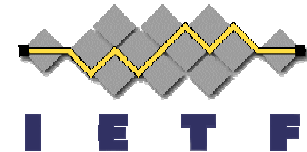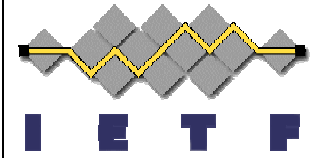# IPv6 Implementation Experience

Margaret Wasserman

<mrw@windriver.com>

What is Wind River?

- Embedded systems software vendor
  - Makers of VxWorks operating system
- Wind River has two IPv6 implementations
  - Independent, small, non–Sockets host stack
    - First version shipped about five years ago
    - Used in consumer equipment, PDAs, etc.
  - Kame–based host & router stacks for VxWorks
    - Router stack used in home gateways, network infrastructure, cell phone infrastructure, etc.
- VxWorks IPv6 program officially launched this week in Tokyo, Japan!
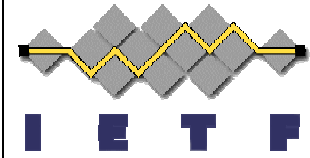
Special embedded needs

- Devices often have restrictive size, cost or battery life constraints
  - All translate to small footprint requirement (code & data)
- Limited device capabilities
  - No disk –– no virtual memory, limited non–volatile storage
- No screen/keyboard
  - All management is remote via SNMP, CLI or Web

- No serious problems found when implementing IPv6 in these environments

What have we implemented?
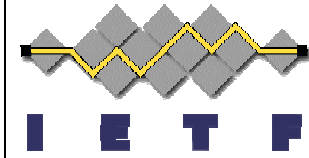
- Core IPv6 functions
  - Host and router implementations
  - Addressing, ND, Address Auto–Config, ICMPv6, Multicast Listener Discovery, Path MTU Discovery, TCPv6, UDPv6, IPv6 over Ethernet
- IPv6 Sockets APIs (& Proprietary APIs)
- Current IPv6 MIB RFCs
- IPv6 compliant applications, including
  - Telnet, HTTP, FTP, SNMP, DNS, DHCPv6 & RIPng
- Transition Mechanisms
 - Generic Packet Tunneling, IPv6 in IPv4 Tunnels, 6to4
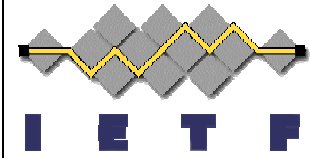
What are we working on?

- IPv6 Security

- PPPv6

- SIP

- Additional routing protocols
  - OSPF, BGP, MPLS…

- NAT−PT

What didn't we implement?
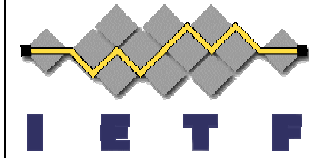
- Site border nodes
  - Site Border Router (SBR) or multi–site host
  - Treat site–local address just like global addresses
  - No customer demand & not sure how to do it right

- Router Renumbering

- No special handling for Anycast

- No A6 DNS records (AAAA resolver only)
  - No customer demand for these two features

How could IPv6 be better?
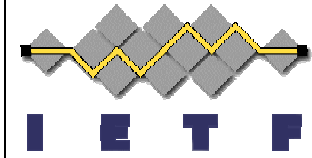
- MIBs should be unified with IPv4 MIBs
  - Transport layers and apps share code, need to check IPv6 version to implement counters, etc.
- Some systems are more complex (larger) than those they replace in IPv4
  - Particularly Neighbor Discovery vs. ARP
    - Both code and data sizes are larger
  - Not a serious problem
    - Moore's law does apply to embedded…
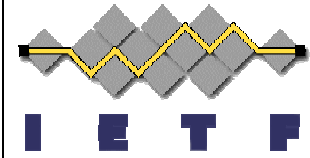
Other concerns

- What is missing from IPv6 that hurts?
  - Prefix delegation (for home gateway)
  - Integrated IPv4/IPv6 MIBs

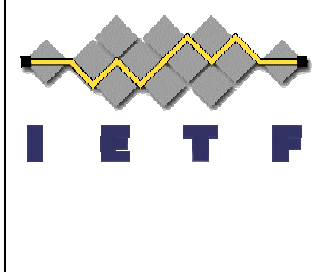- No serious IPv6–specific security or other concerns, yet

Transition Mechanisms
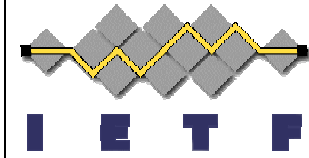
- Generic Packet Tunneling

- IPv6 in IPv4 Tunnels

- 6to4

- NAT−PT Underway

- All implemented due to customer demand
  - Customers are putting these features in products
  - Not clear which ones are/aren't being used
    - Some may be checklist items

Fun things

- What fun things have I done with IPv6 that I could not do with IPv4?

  - Participated in the protocol development
  - Designed and implemented it from scratch